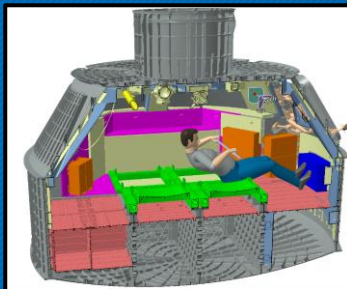




In-Flight Demonstration of the Miniature Exercise Device (MED-2)

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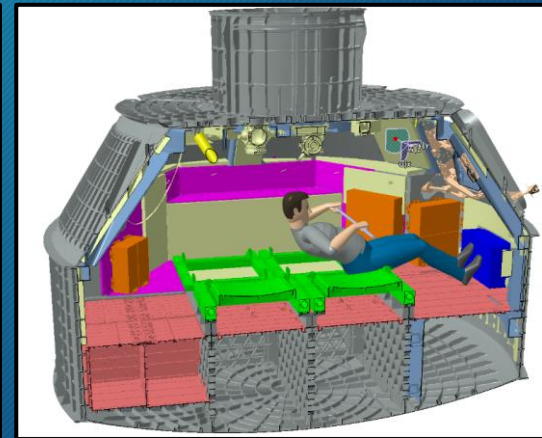
Co-Investigators:

Kent Kalogera, Nate Newby, Renita Fincke, John DeWitt, Andrea Hanson, Craig Maynard, Jeevan Perera, Austin Lovan, Stuart Donnan, Brad Humphreys

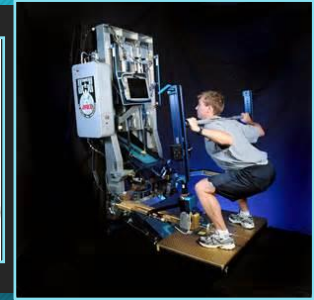
Exploration Mission Background

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- Exploration missions: physically demanding tasks on unfamiliar terrain after being confined to a small vehicle with limited exercise capabilities.
- We need to optimize exploration exercise hardware to protect astronauts health and reduce injury risk.



Project Overview



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BACKGROUND

- MPCV power, mass, and volume limitations for exercise equipment do not allow for ISS-like exercise equipment.
- A small motorized single cable exercise device design was selected for MPCV.

PROBLEM

- The resistance and aerobic exercise capabilities of small motorized single cable exercise devices need to be evaluated in microgravity in order to improve/modify small exercise device designs and optimize crew health during future exploration missions.

SOLUTION

- The MED-2 is a small exercise device selected under the 2 x 2015 1E process (expedite fabrication and launching new ISS hardware).
- MED-2 is currently on ISS (April 2016) and will be used on ISS to understand small exercise device capabilities and inform future MPCV exercise device designs.

MED-2 Description



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- Single cable configuration
- Attaches to the ARED footplate
- Personalized range of motion settings for each exercise
- Software operations via personalized prescriptions or manual control
- Robonaut derived actuator provides variable resistance
- Potential to provide eccentric overload

Study Objectives

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1. Evaluate the feasibility and biomechanical form of performing low, medium, and heavy deadlift loads using MED-2.
 - Compare MED-2 vs. ARED
2. Evaluate the feasibility of high intensity exercise and biomechanical form of performing aerobic rowing exercise using MED-2.
3. Assess the operational envelope of using MED-2 as it relates to fitting within the MPCV designs during rowing and resistance exercises.
4. Evaluate the possible foot placement options for performing resistance exercises while using the MED-2.



Rowing in 1-G



Rowing in
parabolic flight

Methods Overview

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Prior to Start of Data Collection

1. Hardware Checkout & Firmware updates (targeted for February 2017)
2. Camera Placement & Calibration Activity

MED-2 Study Overview

1. Pre-flight MED-2 training (45 min, within 6 month of flight)
2. In-flight procedure review/familiarization
3. MED-2 Ops session x 2 sessions
4. ARED biomechanics x 1 session

Methods (Pre-Data Collection)

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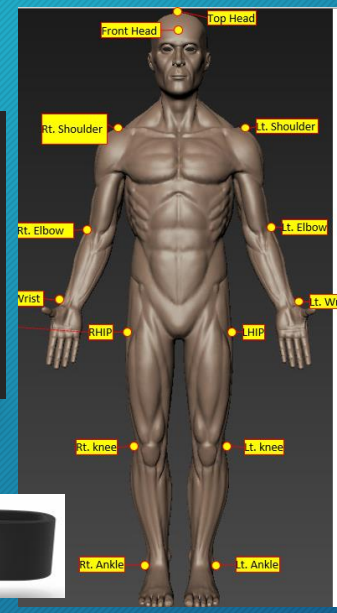
- Hardware Checkout & Firmware updates to allow for higher loading
- Camera Placement & Calibration Activity
 - Dedicated session on ISS to determine ideal camera locations for operational volume and biomechanical assessments during MED-2 exercise



Targeted Camera Views for Camera Placement Activity

In-Flight Data Collection: MED-2

1. Un-stow and set-up MED-2 on ARED
2. Set-up cameras at the specified locations & calibrate.
3. Place reflective markers on the MED-2 device, ARED, and anatomical locations.
4. Don a heart rate monitor transmitter.
5. Perform aerobic rowing exercise
 - 1-3 min at low, medium, high velocity
6. Remove and stow the footplates
7. Perform resistance exercises
 - 5-7 repetitions of deadlift low, medium, high loads
 - Other T-bar exercises (bicep curl, bent-over row, front squat, Romanian deadlift, upright row)
8. Complete the post-exercise questionnaire.
9. Uninstall MED-2 and remove from the ARED.

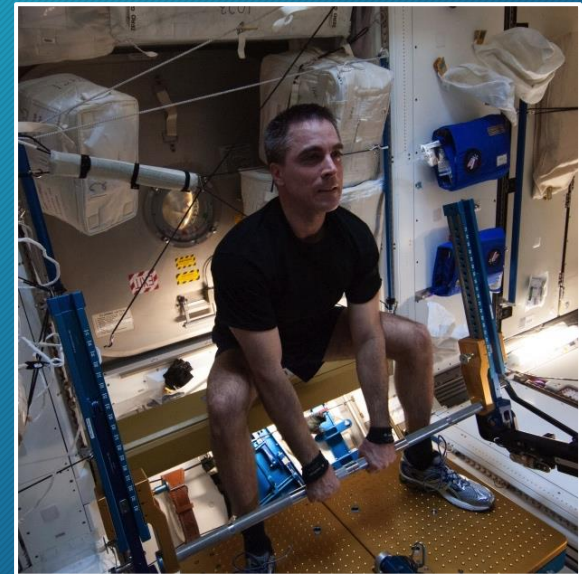


In-Flight Data Collection: ARED

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ARED Biomechanics

- Astronauts will be asked to tape reflective markers at specific anatomical locations and on the ARED during a regularly scheduled 30/60/90 PTV session.
- Astronauts will be asked to set-up the nominal ARED PTV camera and additional cameras required for biomechanical analysis (same camera location used for MED-2 data collection sessions).
- Exercises will be performed as nominally planned by the ASCR for the PTV session.



Immediate Application of Results for MPCV

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- Operational volume assessment will inform:
 - If resistance and/or aerobic rowing exercise can be performed in allocated MPCV operational volume
 - If exercise device platform design or orientation should be adjusted to
 - If exercise form will need to be adjusted
- Ops Video can be used to develop/inform models
- Heart rate data collections will provide information regarding the effectiveness of aerobic rowing as a countermeasure
- Post-session questionnaire will provide feedback on:
 - Motorized exercise experience and potential improvements for the MPCV GUI development/improvements
 - Improvements for MED-2 use on ISS

Where Are We Now...

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Study Progress

- All 6 crewmembers have consented to participate
- Pre-flight MED-2 training completed for crewmembers in pre-launch time frame.
- Hardware checkout is targeted for Feb 2017
- 49S crew targeted for first Ops sessions
- Targeted completion in 52S crew

Future use of MED-2 on ISS

- Potential ISS CMS augmentation
 - Addition of rowing aerobic rowing to ISS for full body aerobic exercise
 - Back-up exercise device in the event of T2, CEVIS, or ARED failure
 - Test bed for ISS training studies to understand the significance of not using the ISS hardware suite.



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Thank you

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